ORIGINAL PAPER

DIELECTRIC BEHAVIOUR OF NEEM SEEDS (*AZADIRACHTA INDICA*)

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Abstract. *The moisture dependent electrical properties of neem seeds have been reported in the present paper. The dielectric constant and dielectric loss have been measured for indian neem (azadirachta indica) seed over the temperature range 15 – 45 °C at varying frequency from 5 kHz to 10 MHz. The measurements have been carried out using electrical impedance spectroscopy. The electrical properties were found to increase with increases in moisture content. The electrical properties for dead seeds have also been measured and compared with the properties of viable seeds for different moisture levels.*

Keywords: *Dielectric constant, Dielectric loss, Moisture content, Azadirachta indica.*

1. INTRODUCTION

Neem (*Azadirachta indica*, Common names: Neem, nim, Indian lilac, nimmi, limbo, limda, margosa) is a native tree of India and in areas up to an elevation of 1850 m, a tropical tree especially suited to semi-arid conditions. In the last 70 years, there has been considerable research upon the properties of neem carried in institutes ranging from the Indian Agricultural Research Institute and the Malaria Research Centre to the Tata Energy Research Institute and the Khadi and Village Industries Commission (KVIC). In view of its' medicinal and commercial value the forest department of Haryana (India) is actively involved in continued plantation of neem tree. Neem is an evergreen tree of the tropics and sub-tropics. It belongs to the family Meliaceae and is becoming increasingly popular for its insect repellant traits and unique property of inhibiting the nitrification process of the soil. Neem is tolerant to most soil types including dry, stony, shallow soils, lateritic crusts, highly leached sands and clays.

An extremely powerful blood purifying agent and detoxicant, neem is also effective in the treatment of fever, malaria, skin diseases, dental problems, diabetes, tumors, arthritis, and jaundice. It has gained particular attention from scientists seeking a cure for AIDS, not only for its antiviral properties, but also because it boosts the immune system on all levels without destroying beneficial bacteria, unlike synthetic antibiotics. Neem has more than 60 valuable compounds. Azadirachtin A is the most important biopesticide. Neem derivatives such as Azadirachtin, nimbicidin and a host of other compounds are now used in medicines and commercial pesticides. Many bioactive ingredients have been identified and isolated, the most

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important ones being azadirachtin and meliantriol. The most active, currently identified ingredient of neem is 'azadirachtin'. Neem cake, the residue from the seeds after oil extraction, is fed to livestock and poultry, while its leaves increase soil fertility. Most importantly, neem is a potent insecticide, effective against about 200 insects, including locusts, brown plant-hoppers, nematodes, mosquito larvae, Colorado beetles and boll weevils [1-7].

The knowledge of dielectric properties of grains and seeds are important because of their application in the moisture measurement **[**8**]** and moisture content measurement is important for the preservation and protection from insects and pathogens [9]. The preservation and protection can be achieved by heating them in such a way that the heat energy destroys only insects etc. without harming the host material [10]. The dielectric properties of seeds are also helpful in studying the viable test [11]. Our group has also reported dielectric properties of many seeds [12-17].

Various studies on neem seeds and its' various product are concentrated on medicinal and commercial uses, but the dielectric properties of the neem seeds has not been explored yet. Therefore, present paper reports the study of electrical properties of neem seeds at different moisture level. The dielectric constant (ε'), dielectric loss (ε'') have been measured to identify the viable and non-viable seeds and to analyze their dependence on moisture.

2. MATERIALS AND METHODS

2.1. MATERIALS

The Neem seeds have been obtained from certified seed research institute (National Botanical Research Institute Lucknow, India). The dust and other foreign materials were removed from the neem seeds used in the present study. The seeds were kept in an air tight container to avoid any moisture gain or loss.

2.2. METHODS

The capacitances (C_p) and dissipation factor ($D_{p)}$ measurements have been done with the help of computer controlled impedance /gain phase analyzer (Model No. -HP- 4194 A) in the frequency range of 5 kHz to 10 MHz, the sample holder was gold plated to reduce dissipation losses. It was calibrated for error removal in measurements using standard liquid C_6H_6 and CCl_4 and the error was found to be less than 1%. The formula for dielectric measurement and the method of getting desired moisture content have been described elsewhere [14].

Temperature of Neem seed have been varied by placing the sample holder in a specially designed double walled glass jacket through which heated oil has been circulated using a refrigerated circulator of Julabo (F-25 model, Germany). The accuracy of the temperature measurement is ±0.01°C.

3. RESULTS AND DISCUSSION

From the figs. 1 and 2, it has been observed that both the dielectric constant and dielectric loss of the complex permittivity decrease with increase in the frequency. This exhibits dielectric dispersion in the material at different frequencies. The high values of dielectric constant at lower frequencies (5, 10, 50 and 100 kHz) and high moisture content could be attributed to high mobility of dipole for free water state and electrode polarization. The high values of the dielectric loss can be attributed to high mobility of water dipole, electrode polarization and increase in ionic and surface conductivity [18]. The relation between dielectric loss and ionic conductivity is given by [19].

$$\varepsilon'' = \varepsilon''_d + \frac{\sigma_i}{\omega \times \varepsilon_0} = \varepsilon''_d + \frac{\sigma_i}{2 \times \pi \times f \times \varepsilon_0} \quad (1)$$

As frequency decreases the ionic loss various inversely with frequency and it becomes negligible in higher frequency region due to the dipolar energy dissipation, which is the predominant loss and ionic loss become almost absent. The dielectric properties of the such materials depends on ionic and dipolar polarization losses.

The change in dielectric constant and corresponding variation in dielectric loss at indicated frequencies showed that the changes in loss factor are less regular than the changes in dielectric constant. The similar behaviour in corn for the moisture range 5 to 10 percent and frequency range 1 to 11 GHz have been reported by Nelson [20]. In other studies [21] on wheat, Corn and Soybean over the frequency range 1 to 200 MHz, similar types of behaviour has also been reported. The complex dielectric relaxation and dispersion phenomena may be one of the causes in the irregularity in loss factor.

From the figure 1 it can be observed that the curves divers and the separations increase between the curves for different moisture levels as we move to the lower end of the frequency range but no change in the curve have been observed for the dead seed and it shows nearly a straight line.

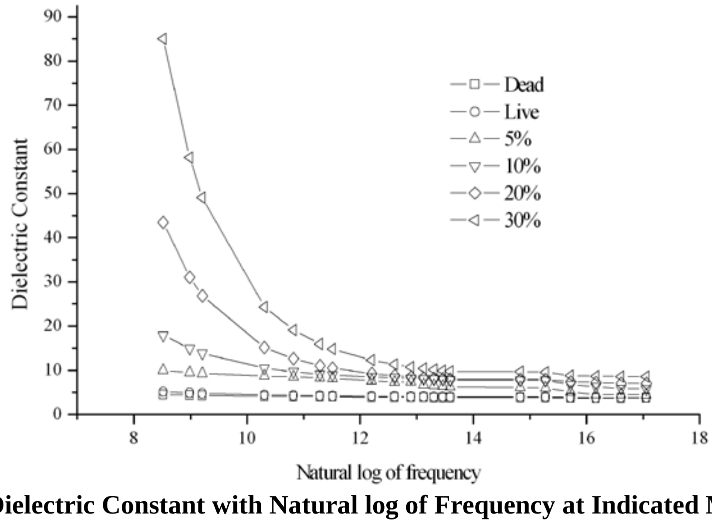

Fig. 1. Variation of Dielectric Constant with Natural log of Frequency at Indicated Moisture Content and 25 °C.

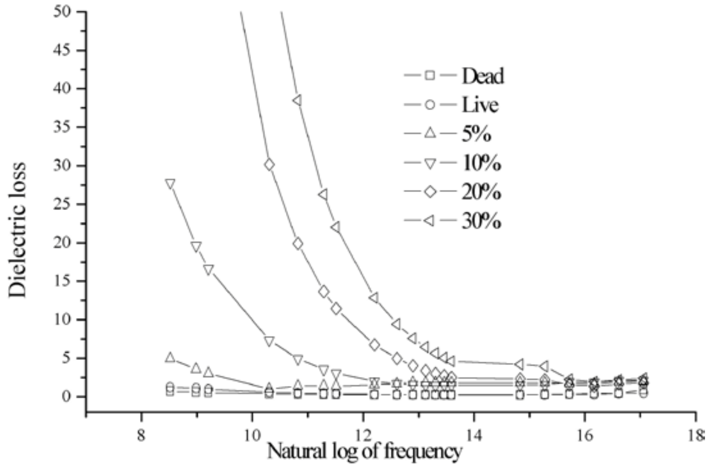

Fig. 2. Variation of Dielectric Loss with Natural log of Frequency at Indicated Moisture Content and 25 °C.

It is clear from figs. 3 – 4 that the complex dielectric permittivity increases with increase in the moisture content at a given frequency and temperature. It can be observed that the rate of increase in ε′ and ε″ is high at 5 kHz and 10 kHz. This may be because of high water mobility. At low moisture content both ε′ and ε″ of the complex permittivity are small because the distance between the water molecule and cell wall is very small [12-17].

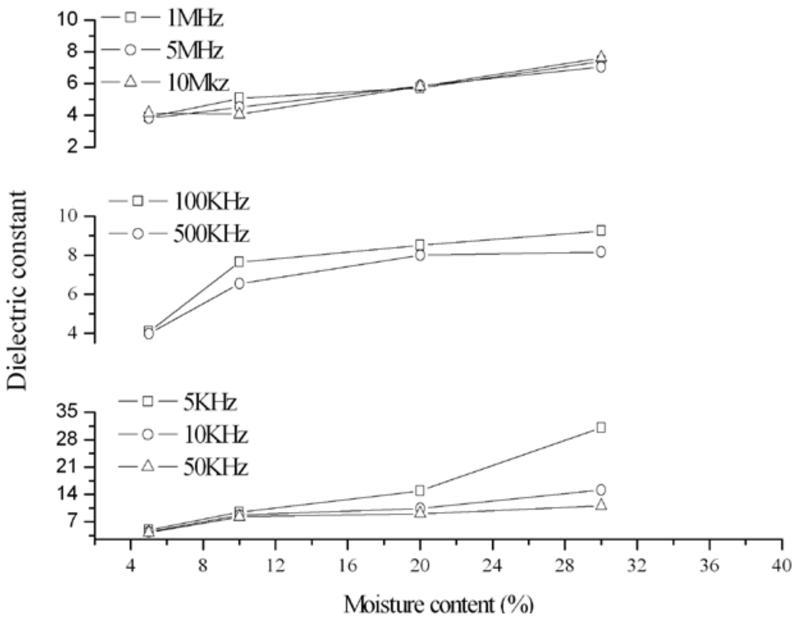

Fig. 3. Variation of Dielectric Constant with Moisture Content at Indicated Frequency and 25 °C.

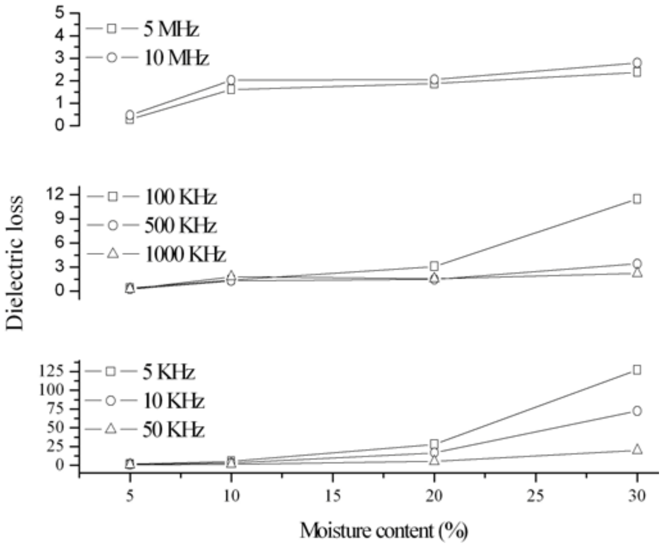

Fig. 4. Variation of Dielectric Loss with Moisture Content at Indicated Frequency and 25 °C.

The figure 5 and figure 6 show temperature dependence of ε′ and ε″ in the temperature range of 15^0C - 45^0C at the different frequencies and moisture levels dielectric constant and dielectric loss increase with increase in the temperature at all moisture levels and frequencies with a slight non-linearity at high moisture content and low frequency, particularly at 10 kHz. The similar variations are also seen in a recent study on temperature dependence of dielectric properties of pecan [22] and fruits [23] in the range of 0^0C – 40^0C.

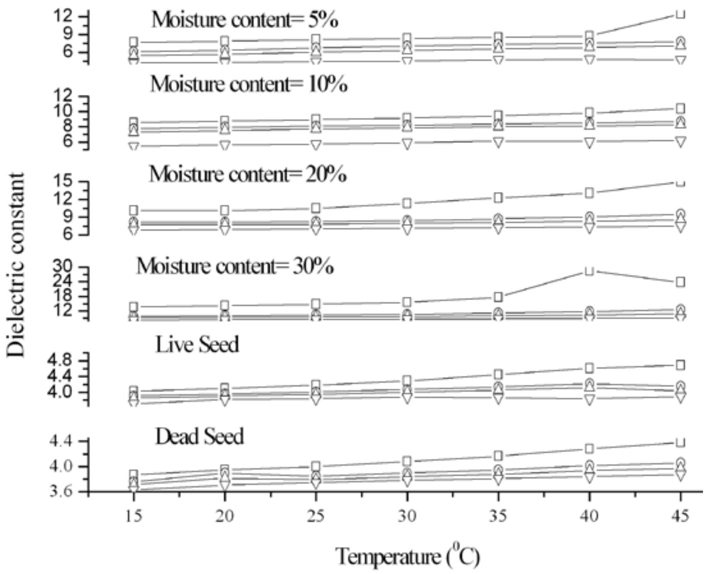

Fig. 5. Variation of Dielectric Constant with Temperature at Indicated Moisture Content and Frequency 100 kHz, 500 kHz, 1 MHz, 10 MHz.

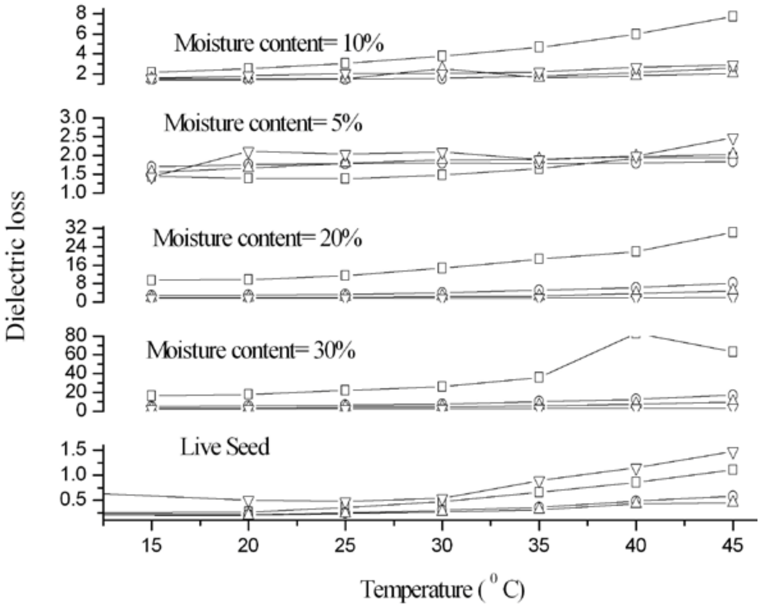

Fig. 6. Variation of Dielectric Loss with Temperature at Indicated Moisture Content and Frequency 100 kHz, 500 kHz, 1 MHz, 10 MHz.

As the temperature increases the molecular mobility increases and relaxation frequency, which is strongly related to the molecular mobility, increases [24]. As temperature increases the ionic conduction also increases which increase dielectric loss. Thus, as temperature increases both dielectric constant ε′ and ε″ increases. The reason has already been explored in our earlier studies.

4. CONCLUSIONS

- It can be concluded that moisture level affect the electrical properties up to a large extent.
- It can be concluded that as frequency increases dielectric constant and dielectric loss decreases.
- But as temperature increases dielectric constant and dielectric loss increases.
- Here electrical properties can be used to measure moisture level which is directly related with germination of seeds and their viable test.

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